IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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		§		
Serial No:	09/885,375	§	Examiner:	Jacob M. Meek
		§		
Filed:	June 19, 2001	§	Confirmation No.:	3992
		§		

For: EFFICIENT CHANNEL ESTIMATION IN A
DIGITAL COMMUNICATIONS SYSTEM

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Commissioner for Patents
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AMENDMENT UNDER 37 CFR 1.111

In response to the Office Action dated September 7, 2005, the Applicant submits the following amendments and remarks. Reconsideration of the application is respectfully requested.

SUMMARY OF AMENDMENTS

Claims 1, 3, 5, and 8-10 have been amended.

Claims 2, 4, 6, 7, and 11-23 have been canceled.

A complete list of pending claims begins on page 2 of this paper.

Remarks begin on page 5 of this paper.

AMENDMENTS TO THE CLAIMS

This listing of claims replaces all prior versions and listings of claims in the application.

Listing of Claims

1.   (Currently Amended) A method ~~for~~ of estimating a transmission channel in a digital communications system which operates in accordance with GSM specifications, said communications system including a receiver which receives a signal transmitted over the transmission channel, said receiver including a channel estimation-based equalizer, said equalizer having a window size adapted to the actual delay spread of the transmission channel, and said equalizer using an estimate of the transmission channel for synchronizing and correcting said received signal, said received signal including a 26-symbol training sequence, said method comprising:

~~using $m+15$ consecutive symbols near the end of said 26-symbol training sequence to estimate, without matrix operation, the transmission channel for different channel spans m, where $1 \leq m \leq 8$;~~

estimating without matrix inversion, the transmission channel for different channel spans m, where $1 \leq m \leq 8$, using at different synchronization points, the last $m+15$ consecutive symbols of the 26-symbol training sequence except for a group of symbols comprising the last four or fewer symbols;

wherein tap values for different synchronization points and tap positions are obtained in a two-dimensional recursive computation step for joint optimization of synchronization and window sizing of the equalizer using Least Square Error (LSE) criterion; and

wherein the tap values for different synch points are calculated in a 2-dimensional "north-west" direction.

2.   (Canceled)

3.   (Currently Amended) The method according to ~~claims 1 or 2~~ claim 1, wherein ~~said~~ the digital communications system operates in accordance with GSM/EDGE specifications.

4.   (Canceled)

5.   (Currently Amended) The method according to ~~claims 1 or 2~~ claim 1, wherein ~~said using step comprises~~ the estimating step includes using delayed (shifted) segments in the training sequence for ~~said~~ the estimation.

6-7.   (Canceled)

8.   (Currently Amended) ~~The method according to claim 1, wherein the consecutive~~ _m_+15 ~~symbols are the last but one~~ _m_+15 ~~symbols, where~~ _m_ ~~is the equalizer window size~~ A method for estimating a transmission channel in a digital communications system which operates in accordance with GSM specifications, said communications system including a receiver which receives a signal transmitted over the transmission channel, said receiver including a channel estimation-based equalizer, said equalizer having a window size adapted to the actual delay spread of the transmission channel, and said equalizer using an estimate of the transmission channel for synchronizing and correcting said received signal, said received signal including a 26-symbol training sequence, said method comprising:

estimating without matrix inversion, the transmission channel for different channel spans _m_, where $1 \leq m \leq 8$, using at different synchronization points, the last _m_+15 consecutive symbols of the 26-symbol training sequence except for a group of symbols comprising the last four or fewer symbols.

9.   (Currently Amended) The method according to claim 1, wherein ~~said~~ the using step ~~comprises~~ includes using a Least Square Error (LSE) approach for ~~said~~ the estimation.

10. (Currently Amended) ~~The method according to claim 2,~~ A method of estimating a transmission channel in a digital communications system that operates in accordance with GSM specifications, said communications system including a receiver that receives a signal transmitted over the transmission channel, said receiver including a channel estimation-based equalizer, said equalizer having a window size adapted to the actual delay spread of the transmission channel, and said equalizer using an estimate of the transmission channel for synchronizing and correcting the received signal, the received signal including a 26-symbol training sequence, said method comprising:

estimating without matrix inversion, the transmission channel for different channel spans m, where $1 \leq m \leq 8$, using at different synchronization points, the last $m+15$ consecutive symbols of the 26-symbol training sequence except for a group of symbols comprising the last four or fewer symbols;

wherein tap values for different synchronization points and tap positions are obtained in a two-dimensional recursive computation step for joint optimization of synchronization and window sizing of the equalizer using Least Square Error (LSE) criterion; and

wherein ~~said using step comprises~~ the estimating step includes using an LSE approach for joint synchronization and equalizer window sizing.

11-23. (Canceled)

REMARKS/ARGUMENTS

Favorable reconsideration of the application is respectfully requested in view of the foregoing amendments and the following remarks.

1.) Claim Status

The Applicant has amended claims 1, 3, 5, and 8-10 herein. Claims 2, 4, 6, 7, and 11-23 have been canceled. Accordingly, claims 1, 3, 5, and 8-10 are pending in the application.

2.) Allowable Subject Matter

On page 10 of the Office Action, the Examiner objected to claims 6 and 10 as being dependent upon a rejected base claim, but stated they would be allowable if rewritten in independent form including all the limitations of the base claim and any intervening claims. The Applicant notes that further amendments to the base claims were also required in order to overcome the rejections under 35 USC § 112 discussed below.

Claim 6 was dependent from base claim 1, with intervening claims 2 and 16. Rather than rewriting claim 6, the Applicant has incorporated the limitations of claims 2, 16, and 6 into base claim 1. Therefore, the allowance of amended claim 1 is respectfully requested.

Claim 10 was dependent from base claim 1, with intervening claims 2 and 16. Claim 10 has been rewritten in independent form including all the limitations of base claim 1 and intervening claims 2 and 16. Therefore, the allowance of amended claim 10 is respectfully requested.

3.) Claim Rejections – 35 U.S.C. § 112

On page 5 of the Office Action, the Examiner rejected claims 1, 11, and 14 under 35 USC § 112, first paragraph, for failing to comply with the enablement requirement. In particular, the Examiner objected to the limitation "without matrix operation" because

use of a matrix is defined by the specification. Claims 11 and 14 have been canceled. The Applicant has amended claim 1 to correct this limitation to read, "without matrix inversion" as described on page 4, lines 19-21. Therefore, the withdrawal of the rejection of amended claim 1 is respectfully requested.

On page 6 of the Office Action, the Examiner rejected claim 1 under 35 USC § 112, second paragraph, for failing to particularly point out and distinctly claim the subject matter which the Applicant regards as the invention. In particular, the Examiner found the term "near the end" (of the 26-symbol training sequence) to be indefinite. The Applicant has amended claim 1 to recite using the last m+15 consecutive symbols of the 26-symbol training sequence except for a group of symbols comprising the last four or fewer symbols. Therefore, the withdrawal of the § 112 rejection and the allowance of amended claim 1 are respectfully requested.

On page 6 of the Office Action, the Examiner rejected claim 8 under 35 USC § 112, second paragraph, for failing to particularly point out and distinctly claim the subject matter which the Applicant regards as the invention. In particular, the Examiner found the limitation, "wherein the consecutive m+15 symbols are the last but one m+15 symbols" to be indefinite. The Applicant has amended claim 8 to recite using the last m+15 consecutive symbols of the 26-symbol training sequence except for a group of symbols comprising the last four or fewer symbols. This limitation clearly quantifies the symbols that are preferably sampled according to the Applicant's invention. Therefore, the withdrawal of the § 112 rejection and the allowance of amended claim 8 are respectfully requested.

4.) Claim Rejections – 35 U.S.C. § 102

On page 7 of the Office Action, the Examiner rejected claims 1-5, 8, 9, 11-14, 16, 18, and 21 under 35 USC § 102(e) as being anticipated by Yakhnich et al (US 6,907,092). Of these claims, the Applicant has canceled claims 2, 11-14, 16, 18, and 21. Claim 1 has been amended to incorporate the allowable limitations of dependent claim 6 and intervening claims 2 and 16. Therefore, the withdrawal of the rejection and the allowance of amended claim 1 are respectfully requested.

The Applicant further notes that the claimed invention estimates the propagation channel efficiently by exploiting the cyclic-prefix nature of GSM training sequences, so that when the height of regression matrix is 16, the "inversed square" of the regression matrix becomes either a scaled identical matrix (for (1-7) tap channels) or in a specific sparse form (8 tap-channel). Due to the delay invariance of the method, efficient channel estimation can be made using the later segments of the training sequence to avoid Inter-Symbol-Interference (ISI) corrupted symbols in the leading position.

In amended claim 1, specific limitations are recited, which make the channel estimation more efficient and ISI-free (from non-training sequence symbols). In particular, the amended claim recites the step of estimating the transmission channel using the last $m+15$ consecutive symbols of the 26-symbol training sequence except for a group of symbols comprising the last four or fewer symbols. Basis for excluding the last four or fewer symbols can be found by inference in the specification. As shown in FIG. 1, channel estimation is performed in prior art GSM systems using the *central 16* symbols of the 26-symbol training sequence. This leaves five symbols that are excluded at the front and back of the training sequence. The specification distinguishes the claimed invention from the prior art by stating that a training sequence segment is selected "close to the end" of the 26-symbol training sequence. (Page 13, lines 13-15). Thus, it is clearly inferred that the selected sequence is closer to the end than the prior art five symbols (i.e., four or fewer symbols).

Claims 3-5 and 9 depend from allowable claim 1. Therefore, the allowance of claims 3-5 and 9 is respectfully requested.

Claim 8 has been rewritten in independent form including the limitations of base claim 1 (as amended to overcome the § 112 rejections above). The Applicant contends this combination is allowable over Yakhnich.

Yakhnich only describes a general LS approach for channel estimation, and does not involve making the estimation computationally efficient. In Applicant's claim 8, specific limitations are recited, which make the channel estimation more efficient and ISI-free (from non-training sequence symbols), notably estimating the transmission channel using the last $m+15$ consecutive symbols of the 26-symbol training sequence except for a group of symbols comprising the last four or fewer symbols.

The Examiner cites column 10, lines 11-31 for disclosing these limitations, but the Applicant respectfully disagrees. The cited passage in Yakhnich does not describe any operation. It describes only the channel model. If further lines are taken into account, e.g., to the end of the page, then a standard LS estimation is described. There is no disclosure or suggestion of any methodology for exploiting any property of the training sequence. If anything, Yakhnich implies that the entire training sequence is used in the estimation, and thus teaches away from the claimed invention, which uses a selected portion near the end of the training sequence.
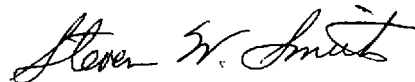
Therefore, the withdrawal of the rejection and the allowance of amended claim 8 are respectfully requested.

CONCLUSION

In view of the foregoing amendments and remarks, the Applicants believe all of the claims currently pending in the Application to be in a condition for allowance. The Applicants, therefore, respectfully request that the Examiner withdraw all rejections and issue a Notice of Allowance for claims 1, 3, 5, and 8-10.

The Applicants request a telephonic interview if the Examiner has any questions or requires any additional information that would expedite the prosecution of the Application.

Respectfully submitted,

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